

SUMMARY

An issue related to the development of the proposed Cross Cascade Pipeline project is the risk of pipeline spills and their attendant potential to impact the environment especially sensitive environments such as specialized habitats, aquatic and wetland environments and special resource areas such as confined groundwater aquifers. A spill analysis was performed that includes:

- Prediction of the expected number of spills that could occur from the proposed project,
- Possible magnitude and configuration of predicted spills, and
- Estimates of residual environmental impacts following response and cleanup.

The spill analysis was conducted in two parts.

In the first part, the expected number of spills from operating the proposed pipeline is calculated to be:

- First 5 years of operation - 0.0466 spills/year (or 1 spill every 21 years)
- Years 5 - 15 - 0.093 spills/year (or 1 spill every 11 years)
- Years 15 - 20 - 0.1118 spills/year (1 spill every 8 years)

These spills could occur at any point along the pipeline route. The probability that one or more spills would occur in any given year along any specific 1000 feet or less of the pipeline (i.e., at any specific location) approaches zero.

Construction and operation of the proposed Cross Cascade Pipeline and reduced reliance on the existing pipeline, barge and tanker truck system for transporting refined petroleum products to eastern Washington markets is predicted to reduce annual spills of refined petroleum products by 4 to 6 spills per year.

In the second part, hypothetical spills at selected locations along the proposed pipeline route were evaluated. While of very low probability, it was found that in certain highly sensitive environments significant short term environmental impacts could occur. However, due to the low probability of a spill at any given location that would expose such resources, the overall risk of significant environmental impacts is extremely small.

INTRODUCTION

The Cross Cascade Pipeline is intended to transport Refined Petroleum Product (RPP or product) from refineries in western Washington to markets in eastern Washington. These markets are currently served by pipeline, barge and tanker-truck transportation systems for import of RPP. Anytime RPP is transported, there is the potential for accidental spill of product and its release into the environment. Indeed, statistical data are available documenting such accidental releases. If the Cross Cascade Pipeline is constructed, it will reduce the use of barge and tanker truck transportation of RPP into the eastern Washington market. It will also provide transportation to accommodate some portion of future product demand growth

As part of the public information process for the project, a series of public meetings were held at communities along the pipeline route. At a number of these meetings members of the public questioned the project proponents about the risk of pipeline spill, subsequent cleanup procedures and residual impact to the environment. Thus, risk of spill is an issue of public concern.

Additionally, the Washington Energy Facilities Site Evaluation Council that has state approval authority and the U.S. Forest Service that acts as federal lead agency must both conduct an environmental review of the proposed pipeline. This environmental review takes the form of an Environmental Impact Statement (EIS) and must consider as part of its evaluation the impacts of the project and the impacts of alternatives to the project, including that of not building the proposed project. The consequence of this latter alternative would be increased reliance on the existing tanker truck, barge and pipeline transportation system. The purpose of this review is to inform the decision makers at both levels of the environmental consequences of the project.

To evaluate the risk and consequence of product spills, the following study has been completed. It includes:

- A comparison of the risks of product spills from the proposed project as opposed to continued use of the existing transportation systems ,
- An evaluation of the potential environmental consequences of product releases.

For the purpose of the study, risk has been defined as the probability of product spill during transmission. These calculations are made on an annual basis to obtain the annual expected number of spills that would occur from barge, tanker truck and pipeline transport of product. As the demand

for products in the future grows, an increase in the number of spills is expected from at least two of the systems, barge and tanker truck transportation.¹

The evaluation of environmental consequences has been based on a set of spill “scenarios”. It is not practicable to evaluate spills at all locations along the pipeline, barge and tanker truck routes. Instead, selected illustrative scenarios that evaluate the environmental consequences of spills are used to compare the project to continued use of the existing system. The scenarios are selected to illustrate a practicable worst case at locations which are in proximity to sensitive environmental resources. A larger number of scenarios have been evaluated for the proposed project than for the existing tanker truck and barge systems.²

1.0 PROPOSED CROSS CASCADE PIPELINE SPILL RISK

Pipeline systems are constructed to prevent the release of their contents. Their design, construction, monitoring during operation, and periodic maintenance procedures are all intended to prevent any accidental releases. However, as with all engineered systems some spills do occur. Based on national statistics and the configuration of the proposed pipeline, the risk of spill can be estimated. National pipeline spill statistics are available that give generalized or average values for expected spill rates.

However, evaluation of these data reveals that the spill rate for a given pipeline is very dependent on the age and diameter of the pipeline (Mastrandrea, 82³). Older pipelines (there are many still in service that are over 50 years old) have significantly higher spill rates. This occurs because they were constructed using oxy/acetylene welding techniques, were constructed with older less precise methods and, especially for the smaller diameter lines, are not frequently maintained or inspected.

¹ Unlike barge and tanker truck spill statistics, pipeline spill rates are generally not dependent on the number of units (gallons or barrels) transported and hence number of trips, but on the total length of the pipeline in operation. Therefore the expected rate of spills from a 100 mile long pipeline is the same if it transports 50,000 barrels per day or 75,000 barrels of product per day.

² No spill scenarios were evaluated for the existing Yellowstone and Chevron pipelines as it is assumed they will continue in operation independent of the proposed project. See section 2.1 for further discussion.

³ Mastandrea, John R., 1982. Petroleum pipeline leak detection study. Office of Research and Development, US Environmental Protection Agency, Cincinnati, OH.

Newer pipelines have demonstrably lower spill rates because they are arc welded with improved weld inspection methods, have more comprehensive cathodic protection, have improved external protective coatings, and are more frequently maintained and inspected. Pipeline diameter also significantly affects spill rates. Larger diameter pipe (usually above 10" diameter) is rolled with proportionally greater wall thickness. This increased wall thickness offers added resistance to third party impacts and corrosion, the most frequent sources of pipeline spills.

To develop a prediction of the number of pipeline spills for the proposed Cross Cascade Pipeline, a failure rate must be selected based on available data and modified to reflect the age and configuration of the proposed project. National Statistics from the U. S. Department of Transportation, the actual operating experience of the existing Olympic pipeline system in Washington, and other recent pipeline studies were examined. Failure rates from these sources are shown below in Table 1-1- Liquids Pipeline Failure Rates.

TABLE 1-1
LIQUIDS PIPELINE FAILURE RATES

Pipeline/Date	Failure Rate (Releases/mile/year)	Comments
Mobil M-70 (Environmental Impact Report - 91)	1.5×10^{-3}	Uncorrected for age and diameter/crude oil
US DOT / (80-89)	1.3×10^{-3}	All hazardous liquid pipelines
Pacific Pipeline (Environmental Impact Report - 96)	0.54×10^{-3} (Leaks) 0.27×10^{-3} (Ruptures)	20" pipe/approximately 20 years old/crude oil
Yellowstone Pipeline (Environmental Impact Statement - 95)	7.0×10^{-4} (Leaks) 3.0×10^{-4} (Ruptures)	Based on new construction/ refined products
Olympic Pipeline (Actual Operations - 1965-96)	1.3×10^{-3}	Actual spill rates 1965 - 1996/includes all spills >50 bbl/refined products

The highest rate shown is 1.5×10^{-3} spills/pipeline mile/operating year which represents an average value for all pipelines uncorrected for age and pipeline diameter. Similarly, the value from the USDOT represents hazardous liquid pipelines of all sizes and ages. The USDOT data base is biased by the prevalence of smaller diameter, older pipelines which generally have higher spill rates. The analyses of the Pacific Pipeline and Yellowstone Pipeline both assumed significantly lower spill rates. In these two cases the failure rates were corrected for age (both would be new construction)

and diameter which yielded the lower values. Olympic Pipe Line's current system shows a spill rate that is similar to the national average⁴.

⁴Olympic's spill history includes a total of 41 releases over its 32 year operating life. Of these, 17 have been spills of greater than or equal to 50 barrels which is the minimum criteria for inclusion in the USDOT data base. Thus to have a failure rate comparable to the USDOT value, Olympic spills of less than 50 barrels were excluded. The average spill size for all remaining Olympic spills was 8.1 barrels. Of Olympic's 41 releases, 12 have been along the pipeline and 29 have been at terminals, junctions or stations. Since these spills occurred at pipeline central facilities they have largely occurred within protective containment minimizing the potential for uncontrolled release to the environment. Except for two large spills, these spills average 65 bbl with 18 being 10 bbl or less.

As the basis for estimating the number of spills from the proposed pipeline the highest value 1.5×10^{-3} , which gives a conservative estimate, was used. This value after correcting for age and pipeline diameter was applied to the 227 mile long pipeline. The pipeline will be constructed in two segments of different diameters. From the Thrasher Station to the Kittitas Terminal the pipeline will be 14" diameter; from Kittitas to Pasco the diameter is reduced to 12". Correcting factors were used to modify the predicted failure rate based on the varying pipeline diameter. Also as previously noted, pipeline age is a factor in failure rates. Varying correction factors were also applied to calculate the increase in predicted failures as the pipeline ages.⁵ The predicted rate of failure or spills for the proposed project is summarized in Table 1-3 Predicted Pipeline Failure Rates - Spills Per Year.

**TABLE 1-2
CASCADE PIPELINE FAILURE RATES**

Segment	Dist. (Miles)	Dia. (Inches)	Pipeline Age		
			0-5 years	5-15 years	15-20 years
			(Failure Rate (Mile/Year))		
Thrasher - Kittitas	120	14	1.87×10^{-4}	3.75×10^{-4}	4.5×10^{-4}
Kittitas - Pasco	107	12	2.25×10^{-4}	4.5×10^{-4}	5.4×10^{-4}

**TABLE 1-3
PREDICTED PIPELINE FAILURE RATES - SPILLS PER YEAR**

Segment	Dist. (Miles)	Dia. (Inches)	Pipeline Age		
			0-5 years	5-15 years	15-20 years
			(Spills per year)		
Thrasher - Kittitas	120	14	0.0225	0.045	0.054
Kittitas - Pasco	107	12	0.0241	0.048	0.0578
Total Expected Spills/Year			0.0466	0.093	0.1118

⁵Correction factors from Mastrandrea, 1982 for pipeline diameter include 0.6 for 12" pipe and 0.5 for 14" pipe. Age correction factors were 0.25 - 0/5 years; 0.5 - 5/15 years; 0.6 - 15/25 years.

Expected Recurrence Interval (Years)	21	11	8
Probability of One or More Spills/Year	5%	9%	11%

This analysis shows that when constructed, the Cross Cascade Pipeline will have an expected spill rate of 0.0466 spills per year. This value can be converted into a recurrence interval that is the equivalent expected number of years between spills. In this case the Cross Cascade Pipeline is predicted to experience a spill every 21 years. The influence of statistically incorporating age data can be seen because the recurrence interval falls from 21 years between predicted spills during the pipelines first five years to on the order of eight years when the pipeline reaches 15 - 20 of age. However, since the age correction factor was developed based on historical data including pipelines of older technology it may not be appropriate to further correct for age beyond 20 years. Thus, the expected number of spills per year is not expected to increase as the proposed pipeline ages further.⁶

Another relative measure of spill risk is the probability, measured as a percent, that one or more spills will occur somewhere along the pipeline in any given year. As with the recurrence interval this calculation is age dependent. The table shows that in the early years of operation a 5% chance of one or more spills is predicted along the pipeline in any given year. As the pipeline ages, the rate will increase to approximately 11%. The chance that a spill would occur along any given 1000 feet of pipeline, which is an approximation of the average landowners frontage along the pipeline right-of-way approaches zero.

2.0 ALTERNATIVE TRANSPORTATION RISK

If the proposed Cross Cascade Pipeline is not constructed, eastern Washington markets for RPP will continue to be served by existing transportation systems. The generalized transportation of RPP into eastern Washington for distribution to eastern Washington, northern Idaho, and northeast Oregon consumer markets is shown on Figure 1 Eastern Washington Market Area Product Imports. This figure shows that eastern Washington is currently served by two pipelines: 1) the Yellowstone Pipeline which originates at refineries in Billings, Montana and terminates at Moses Lake, Washington with an intermediate terminal point at Spokane, Washington and 2) the Chevron pipeline which originates at Chevron's Salt Lake City, Utah refinery and terminates at Spokane, Washington with an intermediate terminal point at Pasco, Washington. This figure also shows two other transportation modes: barges on the Columbia River and tanker trucks on interstate highway routes. Barges on the Columbia River are loaded at Vancouver, Washington with products transshipped from oceangoing barges and tanker ships or from the Olympic pipeline at Olympic's

⁶ Pipeline spill data available through 1979 shows a dramatic decline in the number of pipeline spills, especially for newer pipelines. It could be argued that since the proposed project will be constructed using the most recent operating experience and will undergo more frequent and more sophisticated inspections than were performed historically the spill rate in later years of operation may only increase slightly over the rate predicted for the first five years of operation.

Vancouver Washington terminal. These barges move upriver and discharge their cargoes at Chevron's terminal at Pasco. From there, they are sent on to Spokane in Chevron's pipeline or dispersed to the regional market in southern Washington, northeast Oregon, and northern Idaho by tanker truck. In addition, tanker trucks are loaded at terminals in the Seattle area (principally Harbor Island) and transport their cargoes to eastern Washington via interstate Route 90.

FIGURE 1
EASTERN WASHINGTON MARKET AREA PRODUCT IMPORTS

Both the National Environmental Policy Act (NEPA) and the state of Washington's State Environmental Policy Act (SEPA) require environmental evaluation of the "No Project Alternative" as part of their respective environmental review procedures. From a regulatory perspective, the No Project Alternative is, in effect, denial of the proposed project and continued use of the existing transportation systems to supply the eastern Washington market with RPP.

2.1 EASTERN WASHINGTON RPP DEMAND

To provide a basis for comparing the risk of spill for the proposed project to the No Project Alternative, the total number of trips for alternative transportation systems must be determined and a spill rate must be estimated for the existing transportation system. This analysis applies only to the barge and tanker truck modes of transportation. It is assumed that the two existing pipelines,

Yellowstone and Chevron, will continue to serve the eastern Washington market at their current capacity (Yellowstone transported on average 28,500 bpd in 1985 and Chevron 6,300 bpd) and would not accommodate any increased eastern Washington demand.⁷

In 1995 total demand for RPP in eastern Washington was approximately 82,500 bpd⁸. This was supplied as follows:

Tanker Truck/Western Wash.	12,300 bpd	15%
Barge up Columbia River	35,263	43%
Yellowstone Pipeline	28,641	35%
Chevron Pipeline	6,331	7%

Forecasts of increase in demand for RPP prepared by Energy Analysts International, Inc.⁹ show an average increase on the order of 1.5% to 1.8% growth per year. By applying this growth uniformly to the actual demand in 1995 and projecting out over a reasonable time period, demand growth can be determined. Projected demand based on a growth rate of 1.5% is shown in Table 2-1 - Eastern Washington Product Demand 1999 - 2019.

TABLE 2-1
EASTERN WASHINGTON PRODUCT DEMAND 1999-2019 (BPD)

	1999	2004	2009	2014	2019
Total Forecasted Demand	88,305	95,130	102,482	110,402	118,935
Truck	13,590	15,324	17,191	19,203	21,370
Barge	39,915	45,006	50,491	56,399	62,764
Subtotal	53,505	60,330	67,682	75,602	84,134
Yellowstone Pipeline	28,500	28,500	28,500	28,500	28,500
Chevron Pipeline	6,300	6,300	6,300	6,300	6,300

⁷ While the Yellowstone pipeline is currently operating in a curtailed status, it is assumed that pipeline route approvals which are currently under review will be resolved in Yellowstone's favor and Yellowstone will return to its previous level of operation. For either Chevron or Yellowstone to increase thruput on their systems would require an increase in the production capacity of the Billings and Salt Lake City area refineries and such increased production must compete economically with other closer markets.

⁸ Source: Yellowstone Pipeline EIS/supporting technical report prepared by Energy Analysts International, Inc., 1995

⁹ Report prepared by Energy Analysts International, Inc. For Texaco Trading and Transportation, Inc. 1995

Subtotal	34,800	34,800	34,800	34,800	34,800
----------	--------	--------	--------	--------	--------

The allocation of volumes transported by barge and tanker truck have been maintained at the current relative percentages. The distribution between these two systems is primarily a function of the unit shipping price and required destinations. Assuming that future demand grows relatively uniformly throughout the market area and that shipping rates and tariffs continue in their present relationship, the proportional distribution between the two systems will remain essentially the same.

There are several factors which would affect redistribution of volumes transported by either barges or tank truck. For example since Olympic's pipeline to Vancouver, Washington, where current cargoes to eastern Washington are loaded, is reportedly at capacity any increase in deliveries by barge up the Columbia will require increased imports (i.e., deliveries via ocean-going barge or tanker from western Washington refineries or California refineries to Portland) to the region. Such imports must compete economically with tank truck deliveries from Seattle which can bypass the congested Olympic pipeline to Portland, a river barge trip from Portland to Pasco and finally transshipment to the Chevron pipeline between Pasco and Spokane. If the Tri-cities region (Pasco, Kennewick, Hanford) experiences relatively greater growth than other areas, then barge deliveries to this area could proportionally increase. However, this would also require increased regional imports. If the Spokane region grows disproportionately greater in the future then this growth could be served by increased tanker truck deliveries.

The demand forecast has been extended for twenty years beginning with initial project operation in 1999 and reported in five year intervals. Given the variability in long term growth rates, extension of a growth rate forecast beyond 20 years was considered to be unreasonable.

To convert volume transported to number of trips, the unit volumes of barges and tanker trucks from the existing fleet were used. It was assumed that the current average capacity of tanker trucks of 8,000 gallons/load (190.5 barrels/load) will not be significantly increased in the future. Current over-the-road truck load weights are limited by highway pavement designs. Without significant advancements in pavement design or modification of truck designs to increase payload capacity, increased truck loads in the future is unlikely. The current barge fleet operating on the Columbia consists of three large liquid bulk barges with approximately 65,000 bbl capacity, and smaller 30,000 bbl capacity dual use dry/liquid bulk barges. The current trend is to discontinue the use of smaller dual purpose barges for transport of product cargoes and to utilize the existing fleet of larger liquid bulk barges exclusively. It is assumed that one new large barge will be added to the fleet and that future growth in demand will be satisfied by adding standard barges to the fleet.

Based on the assumptions of tanker truck and barge fleet composition, the annual number of trips required to satisfy increased product demand is shown on Table 2-2 - Trip Demand. Trip demand has been shown in 5 year increments out to 20 years. Without construction of the Cross Cascade Pipeline, tanker truck trips will increase 58% and barge trips will increase 45%. Tanker trucks, which average 65 departures per day from Seattle at present will increase to 112 departures in 2019. Similarly, barge departures, which average almost one per day presently, will reach a level of one

to two departures per day in 2019. Since both tanker truck and barge trips are one way trips, total highway and river traffic volume will be twice the amount shown in Table 2-2.

**TABLE 2-2
TRIP DEMAND**

	1999	2004	2009	2014	2019
Truck (daily)	71	80	90	101	112
Truck (annual)	26,039	29,361	32,939	36,793	40,946
Barge (large, annual)	292	292	292	292	292
Barge (small, annual)	0	0	0	54	131
Barge (total, annual)	292	292	292	346	423

2.2 TANKER-TRUCK TRANSPORTATION SPILL RISK

The U.S. Department of Transportation (USDOT) maintains current and historical data on vehicle accidents from across the country. Based on reviews of nationwide tractor trailer accident data, the USDOT has determined that tractor trailer accidents occur at a frequency of 3.51×10^{-6} accidents/truck-mile (USDOT, 1990¹⁰). In addition, the USDOT has determined that for tractor trailer accidents involving the spillage of hazardous materials, a total of 0.188 spills/accident can be expected to occur (USDOT, 1990). Combining these two factors yields a predicted spill rate of 6.60×10^{-7} spills/truck-mile. Using this spill rate the expected number of spills per year that would occur from tanker truck trips (as forecasted in Table 2-2) is shown on Table 2-3. These predicted values are based on a one-way trip from Seattle to Pasco of 218 miles. The increased number of spills in later years is the result of increased demand for truck transportation not an increased spill rate.

**TABLE 2-3
PREDICTED TANKER TRUCK SPILLS**

	1999	2004	2009	2014	2019

¹⁰ US Department of Transportation, Federal Highway Administration 1990. Present Practices of Highway Transportation of Hazardous Materials. Research, Development, and Technology of Turner-Fairbank Highway Research Center, McLean, Virginia.

Annual Expected Spills	3.7	4.2	4.7	5.3	5.9
------------------------	-----	-----	-----	-----	-----

2.3 RIVER BARGE TRANSPORTATION SPILL RISK

Based on a review of national and Puget Sound regional data on barge spills, Cohen and Aylesworth (1990)¹¹ have calculated tanker barge spill rates that can be used to predict the expected number of spills per year that would occur based on the demand for barge transportation shown in Table 2-2.

According to this report, loaded tanker barges are predicted to have 7.03×10^{-7} spills per kilometer traveled. Also in Cohen and Aylesworth, 1990, tanker barges are predicted to have 6.6×10^{-5} spills per port call. Assuming a one-way tanker barge transit distance from the Portland/Vancouver terminal to the Pasco terminal of approximately 336 km., and two (2) port calls per transit (load/unload), the resulting total predicted spill frequency is shown in Table 2-4.

It should be noted that some portion of the supply of product currently shipped via barge up the Columbia to eastern Washington originates in western Washington or California refineries. As previously noted any increase in barge transportation from Portland to Pasco can only be additional barrels of product from western Washington or California. These supplies would arrive in Portland on ocean going barges or tanker ships making voyages of approximately 834 miles from San Francisco and approximately 458 miles from Puget Sound. These transits and their associated port calls add additional risk of spill which should be added to the barge spill risk. However, because the number and origin of such trips is difficult to estimate they have not been included in the analysis. Their exclusion favors the barge spill risk portion of the analysis by reducing the risk to a value less than it would otherwise be.

**TABLE 2-4
PREDICTED BARGE SPILLS**

		1999	2004	2009	2014	2019
Annual Expected Spills	Barge (In-transit)	0.069	0.069	0.069	0.082	0.100
	Barge (Port Call)	0.039	0.039	0.039	0.046	0.056
	Barge (Total)	0.108	0.108	0.108	0.127	0.156

3.0 COMPARISON OF SPILL RISK

¹¹ Oil Spill Risk for Southern B.C./Northern Washington Coast Marine Area, February, 1990

As previously noted federal and state environmental review requires that the impacts of the project be compared to the No Project Alternative. In the case of spill risk this evaluation is made by comparing the expected number of pipeline spills (the Project Alternative) to continued use of the existing transportation system (the No Project Alternative). In recognition that total transportation demand will increase in the future and that pipeline spill risk is somewhat dependent of pipeline age, this comparison is made with respect to time. The comparison of spill risk for the project and No Project Alternative is given in Table 3-1 - Comparison of Project/No Project Expected Spills Per Year.

**TABLE 3-1
COMPARISON OR PROJECT/NO PROJECT
EXPECTED SPILLS PER YEAR**

	2004 (5 years)	2009 (10 years)	2014 (15 years)	2019 (20 years)
	(Expected Spills/Year)			
Proposed Cross Cascade Pipeline	0.0466	0.0932	0.0932	0.1118
No Project Alternative ¹²				
Tanker Truck	4.224	4.739	5.294	5.891
Barge	0.108	0.108	0.127	0.156
Subtotal	4.332	4.847	5.421	6.047
Project Decrease/Increase Spills/Year	-4.3	-4.8	-5.3	-5.9

Table 3-1 shows that construction of the Cross Cascade Pipeline will reduce the risk of product spills during transportation of RPP to eastern Washington markets. The table further demonstrates that the number of spills prevented will increase with time. The predicted reduction of spills ranges from approximately four spills per year during the first five years of operation to approximately six spills per year after 20 years of operation. It should be noted that the actual number of spills prevented is most highly dependent on future demand growth. If growth rates are slower than the 1.5% per year used in this forecast, the spill reduction will likewise be smaller. If no growth in demand were to occur at all and the Cross Cascade Pipeline simply replaces current tanker truck and barge transportation, the reduction in annual spills would still be approximately 3.5 spills per year.

¹²Spills from the Yellowstone and Chevron Pipeline have not been included. In the analysis these pipelines were assumed to continue operating at the same level for both the project and No Project Alternatives. Any spills they do generate would be the same for both alternatives, giving no contribution to the difference between alternatives. Therefore, they were omitted from the analysis.

4.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS

Neither the proposed Cross Cascade Pipeline nor the No Project Alternative consider release of refined petroleum product to the environment to be part of normal operations. All transportation systems are designed and operated to prevent or minimize such occurrences; when releases do occur, they are accidental spills. As such, evaluation of the environmental consequences of accidental spills cannot be made with reference to a known or expected release of a specific size, location and duration. Instead scenarios which represent “assumed” accidental spills are constructed and evaluated. In the following sections a set of theoretical spill scenarios are described and the potential for environmental impact as the result of such accidental releases assessed. It should be noted that delineation of a specific scenario does not mean that such a spill is expected to occur. Indeed, the calculation of pipeline spill probability, discussed in Section 1.0, shows that the probability of such an occurrence is extremely low.

Individual spill scenarios provide the basis for evaluation of potential impacts. Such an evaluation includes consideration of the extent, severity and duration or persistence of impacts resulting from a spill and the following emergency response and cleanup activities. Review of the impact assessment of the scenarios then provides for an assessment of the potential threat to the environment posed by both the proposed project and No Project Alternative.

4.1 SPILL SCENARIOS - DEFINED

Each spill scenario includes a description of the spill event, prototypical emergency response and consequent environmental impacts. Spill scenarios have been developed for the existing barge and tanker truck transportation methods of shipping refined petroleum product to eastern Washington and the proposed Cross Cascade Pipeline.

The scenarios are based on sets of circumstances which may or may not occur in the same sequence or combination in an actual spill incident. The scenarios are not intended as a comprehensive outline of expected spill response, nor should they be regarded as predictions of specific spill response procedure performance. They are used for illustration and assessment purposes only. An actual spill response would be tailored to the existing site conditions and requisite response requirements.

The spill scenarios are summarized on Table 4-1 and described in detail in Appendix A. The spill events outlined in Scenarios 1 through 12 occur along the proposed pipeline route. Scenarios 13 through 17 depict spills events associated with alternative methods of transporting petroleum products to eastern Washington. These scenarios include transport overland by highway tanker truck, by river barge along the Columbia River and by oil tanker through the Straits of Juan de Fuca. The latter scenario and one of the Columbia River scenarios are included to examine the risks from transportation of RPP from western Washington and California refineries to Portland for transshipment to eastern Washington markets. As noted in Section 2.3 the probability of spills related to such product movements has not been included in the analysis. However, these movements will occur as a result of increased barge transportation to eastern Washington and therefore are included in the impact assessment.

Spill scenario locations and the mode of pipeline failure were selected to illustrate and evaluate potential impacts to sensitive resources occurring along the proposed pipeline route. Specific issues considered in the selection of scenario locations included:

- Sole source and shallow ground water aquifers
- Small streams of both high and low surface water flowrates
- Wetlands
- Sensitive/critical wildlife habitats
- Lake habitats
- Locations with difficult access (topography, weather conditions)
- Adjacent urban/recreation land uses.

The specific scenarios were reviewed with state and federal agencies and representatives of affected counties for their input and comment. The spill volumes assumed for each scenario (Scenarios 1 through 12) represent the practical worst case discharge volumes.¹³ The discharge volumes were determined by the duration of the release multiplied by the flow rate/capacity of the pipeline (barrels or gallons per hour) and the line drainage volume subsequent to shutdown of the line. The short term spill duration assumes that the pipeline completely ruptures. The long term spill duration assumes that a small leak (e.g., <1 inch diameter) occurs in the pipe. Response times by OPL personnel assume the emergency response trailers would be available at the OPL pump stations and terminals along the pipeline route. Spill Scenarios 13 through 17 illustrate probable discharge volumes associated with highway, river and marine transport of petroleum products. The scenarios assumed adverse weather conditions existed to complicate the response and cleanup issues.

A description of the spill characteristics, affected environments, and cleanup responses for each scenario is outlined in Appendix A.

4.2 ASSESSMENT OF IMPACTS OF OIL SPILLS

This assessment separates the evaluation of impacts on human health, safety, and living from impacts on physical and biological resources. The first part focuses on methods of analysis. The second part addresses effects on biological resources and their habitats. The third part covers potential impacts on humans.

METHODS OF ANALYSIS

The severity of impacts from spills of petroleum products to the environment are a direct function of five factors:

¹³The definition of practical worst case includes limitations on drain down as a result of topography, pipeline hydraulics, and block valve spacing. See Appendix B for a description of the methodology used for estimating spill volumes.

- The types of products spilled (gasoline or diesel and diesel-like products)
- The size of the spill
- The local conditions at the time and place of the spill

TABLE 4-1
SUMMARY OF RELEASE SCENARIOS
OPL CROSS CASCADE PIPELINE

- The receptors of the impact and their characteristics
- The specific emergency response and cleanup activities used.

There are several components of impact that vary with certain spill conditions. The magnitude or intensity of the impact can relate to the amount of product spilled, the amount of area that receives it, whether the spill site is saturated with water, and the concentration and type of receptors affected.

The extent of the impact is determined by factors that constrain the travel of the spilled products and whether secondary actions take place, like a fire or a cleanup action that has severe effects on the land and vegetative cover. The duration of the effects relates to the persistence of the spilled product in the environment, the habitat effects, and the kinds of cleanup activities used. The perceived importance of receptors is also likely to affect the perception of the impacts. Some resources are important enough to be protected by specific laws. The sensitivity of receptors to the impacts also varies, with some being more resilient or able to recover faster than others. Some types of spills have a much greater likelihood of occurring than others, and that must be factored into the impact analysis.

IMPACT CHARACTERISTICS OF REFINED PETROLEUM PRODUCTS

Crude oil and petroleum products were classified in four classifications in API(1995¹⁴). Two of the four types correspond to the Cross Cascade Pipeline Project product types. All gasoline products were placed in one type with the following characteristics:

- Very volatile and highly flammable (flash point near 100°F/40°C)
- High evaporation rates
- Narrow cut fraction with no residues
- Low viscosity, spread rapidly to a thin sheen
- Specific gravity less than 0.80
- High acute toxicity to biota
- Do not emulsify
- Will penetrate substrate; nonadhesive

Diesel-like products (includes No. 2 fuel oil, jet fuels, and kerosene) in a second type with the following characteristics:

- Moderately volatile (flash point varies 100-150°F/40-65°C)
- Refined products can evaporate to no residue (crude oils do have a residue)

¹⁴ Options for Minimizing Environmental Impacts of Freshwater Spill Response - NOAA/American Petroleum Institute, 1995.

- Low to moderate viscosity; spread rapidly into thin slicks
- Specific gravity of 0.80-0.85
- Moderate to high acute toxicity to biota; product-specific toxicity related to type and concentration of aromatic compounds
- Can form emulsions
- Tend to penetrate substrate; fresh spills are not adhesive

The direct effects of these two types of products on living organisms differs somewhat based on the above characteristics. Gasoline is more acutely toxic than diesel products, but evaporates faster. Diesel readily emulsifies in water, increasing its viscosity and its volume, while gasoline does not emulsify. Both types of products tend to penetrate the substrate rather than adhere to the surface.

The analysis of impacts uses a matrix addressing the level of each of the impact components for each scenario¹⁵. To assess the significance of the impacts, the combinations of components are evaluated against a standard of comparison. The components and their levels are given in Table 4-2 Severity of Impact as shown below.

TABLE 4-2 SEVERITY OF IMPACT

Type	Magnitude (S,M,L)	Extent (S,M,L)	Duration (Long, Mod, Short)	Importance of Receptors (H,M,L)	Sensitivity of Receptors (H,M,L)
Negligible	S	S	S	L	L
Minor	S, M	S	S, M	L, M	L, M
Moderate	M, L	S, M	S, M	L, M	L, M
Severe	L	L	L	H	H

¹⁵ This assessment uses information and approaches developed by others where it is helpful. For example, the American Petroleum Institute and the NOAA Hazardous Materials Response & Assessment Division published "Options for Minimizing Environmental Impacts of Freshwater Spill Response (API 1995). It characterizes common response and cleanup methods and assesses their impacts on various freshwater habitats and species. It also characterizes different types of oil and products and their impact characteristics. Other EISs and EIRs have also been used as source documents.

Magnitude (or intensity):	S = small, M = moderate, L = large
Extent:	S = small, M = moderate, L = large
Duration of Effects:	Long = long term, Mod = moderate time, Short = short term
Importance of Receptors:	H = high (as T & E species), M = moderate (as PHS), L = low (as common and abundant species and habitats)
Sensitivity of Receptors:	H = highly sensitive and vulnerable, M = moderately sensitive and vulnerable, L = low sensitivity or vulnerability

BIOLOGICAL IMPACTS

Impacts on biological resources can include direct impacts of the spilled product on the organism (toxic effects, smothering, or modification of features like insulation layers that allow death from low temperature, or death from fire, if that occurs). Other important impacts include modification of habitat by killing vegetation directly or through the cleanup efforts, such as removing contaminated soil or building access roads or fire breaks. Loss of organisms that serve as food for other species can also have a major effect.

The impacts of each scenario are described below based on the detailed spill scenarios in Appendix A. The impacts are summarized by the estimated level of each impact component as given in Table 4-2 and then shown in Table 4-3 Summary of Environmental Impacts/Scenario.

Scenario 1 - Near Little Bear Creek

1a1 - Large Volume, Short Duration Gasoline Spill

The magnitude or intensity of the impact from the gasoline itself is high in the wetland and nearest stream edges where high concentrations of gasoline collect. As the spill moves downstream and disperses to lower concentrations, the magnitude drops to moderate and then small. There are areas of the wetland occupied by the containment berms, which is a high intensity action, and very small areas where booms are deployed have small physical impact. An area 100 by 150 feet is excavated in the wetland, totally removing the wetland vegetation (a high-magnitude impact). The gasoline and the excavation modify the soil conditions so that recovery of wetland vegetation is slow. Only very tolerant species like reed canary grass are likely to recolonize.

The extent of the impacts is large, in that gasoline spreads down Little Bear Creek for four miles to the last set of booms. Some low concentrations (chronic effects levels) extend beyond that in the Sammamish River and Lake Washington.

Duration of the effects is moderate, since gasoline evaporates. However, in the wetland area where excavation occurred, the change in the wetland character represents a long-term degradation.

The importance of receptors is high because of anadromous fish use of the streams and acute toxicity to aquatic organisms that provide trophic support to these fish. The wetland and riparian stream edge are at least moderate in importance.

The sensitivity of receptors is high, in that many of the ones that come in contact with the gasoline will suffer toxic effects.

1a2 - Large Volume, Short Duration Gasoline Spill with Fire

The magnitude or intensity of the impact is high. The major effects result from fire, but some acute toxicity may occur to aquatic organisms.

The extent of the impacts is large. Everywhere the gasoline goes, so does the fire, and after some vegetation catches fire, it spreads to adjacent areas.

The duration of the effects is short for many herbaceous species, but moderate for shrubs that sprout back from roots or long for trees or shrubs that have to be replanted and may take several years to reach a comparable stature.

The importance of receptors is high because of the anadromous fish use of the streams and the potential acute toxicity to aquatic organisms that provide trophic support to the fish. If the water temperature increases substantially from the layer of burning gasoline on the water surface, aquatic organisms may be killed. The wetland and riparian stream edge are at least moderate in importance.

The sensitivity of receptors is high to fire. If heat from the fire is high enough, even the roots of plants may be killed.

1b - Small Volume, Longer Duration Spill

The magnitude or intensity of the impact of the gasoline itself is moderate, smaller than with the larger short-term spill at this location, because a much smaller amount of product is spilled over a longer time period, and the intensity reduces with distance from the spill due to evaporation and dispersion. There are areas of the wetland occupied by the containment berms, which is a high intensity action, and very small areas where booms are deployed have small physical impact. An area 100 by 150 feet is excavated in the wetland, totally obliterating the wetland vegetation (a high-magnitude impact). The gasoline and cleanup excavation modify the soil conditions so that recovery of wetland vegetation is slow. Only very tolerant species like reed canary grass are likely to recolonize.

The extent of the impacts is large, in that gasoline spreads down Little Bear Creek for four miles to the last set of booms. Some low concentrations (chronic effects levels) extend beyond into the Sammamish River and Lake Washington.

Duration of the effects is moderate, since gasoline evaporates. However, in the wetland where the excavation occurred, the change in the wetland character will be a long-term degradation.

The importance of receptors is high because of the anadromous fish use of the streams. The wetland and riparian stream edge are at least moderate in importance.

The sensitivity of the receptors is rather high, in that many of the ones that come in contact with the gasoline will suffer toxic effects.

Scenario 2 - Tualco Valley

2a - Large Volume, Short Duration Gasoline Spill

The magnitude or intensity of the impact is high within the small tributary and the Snoqualmie River immediately downstream reducing to moderate within 2.5 miles of the spill at the last containment boom. Soil remediation near the spill requires excavation of an upland area 450 by 50 feet (a high-intensity impact).

The extent of the impacts is large. Most of the impacts are restricted to the 2.5 miles, although some chronic-level concentrations extend down the Snohomish River.

The duration of the impacts is moderate, since gasoline evaporates and no excavation of sensitive habitats occurs.

The importance of receptors of impacts is high with respect to the anadromous fish runs in the Snoqualmie River.

Sensitivity of receptors is moderate, in that the gasoline is on the surface and would likely evaporate in a short time relative to the amount of the run of salmon or steelhead (in any life stage) that would be present in the impact area.

2b - Small Volume, Longer Duration Spill

The magnitude or intensity is relatively high, since there is enough gasoline in the affected area to kill most organisms in it. The cleanup excavation area also has a high intensity impact.

The extent of the impacts is small, since it is contained in a few hundred feet of tributary stream.

The duration of the impacts is moderate, since gasoline evaporates and no excavation of sensitive habitats occurs.

The importance of receptors is on the low side of moderate, including only the upland and the small stream, neither of which contains high-importance species or habitats.

The sensitivity of receptors is low, in that the vegetative cover can be regenerated after the cleanup.

Scenario 3 - Harris Creek, Large Volume, Short Duration Diesel Spill

The magnitude or intensity of the impacts of the product itself is high. The area excavated (50 by 200 feet) also has high intensity impact.

The extent of the impacts is large, affecting several acres of wetland and four miles of Harris Creek.

The duration of the impacts is moderate to long term. The excavated area would probably be permanently altered in character, and the diesel is more persistent than gasoline. It is likely that effects on the wetlands and riparian areas could be seen for several years, although the overall character in terms of the type of cover may not change.

The importance of receptors is moderate to high because of the high value wetlands and the salmonid fish runs in the affected stream.

The sensitivity of receptors is high for fish and other aquatic organisms.

Scenario 4 - Mt. Si Golf Course, Large Volume, Short Duration Gasoline Spill

The magnitude or intensity of the impacts is high. A large volume of gasoline goes into a fairly confined space of Meadowbrook Slough. Fire suppression foam is also assumed to be present, and it may have further toxicity or longevity.

The extent of the impacts is moderate, including about 10 acres of upland and 20 acres of wetlands.

The duration of impacts is moderate. The gasoline is allowed to evaporate. The wetland vegetation recovers over a period of two to five years.

The importance of receptors is moderate. The wetland is highly affected. If rearing juvenile fish are present, they would be of high importance and vulnerability.

The sensitivity of receptors is high for both wetlands and fish.

Scenario 5 - I 90 Crossing, Small Volume, Short Duration Gasoline Spill

The magnitude or intensity of the impacts is high within the first boomed area in the river and moderate downstream for 1.5 miles. The snow and frozen ground offers some protection for upland areas, and the intensity of impact there is moderate.

The extent of the impacts is moderate for the high intensity impact and large for lower impacts, as the spill rapidly dissipates downstream.

The duration of impacts is moderate due to containment and evaporation.

The importance of receptors is moderate, including resident salmonids and riparian habitat.

The sensitivity of receptors is moderate because the spill intensity in the water is localized, allowing for a small part of the fish population to be exposed and perhaps escape. Upland receptors are less sensitive.

Scenario 6 - Ollalie Creek Near Snoqualmie Pass, Moderate Volume, Short Duration Diesel Spill

The magnitude or intensity of the impacts is moderate for the most sensitive receptors, since it is a winter spill when the biota are less active. The upland habitats will have high-intensity impacts.

The extent of the impacts is moderate, since only a small part of the spill volume reaches the creek for dispersion downstream and only minor amounts reach the South Fork of the Snoqualmie River.

The duration of the impacts is moderate, since the diesel takes longer to evaporate than gasoline and the vegetation and aquatic resources affected will take probably 2 to 5 years to recover.

The importance of receptors is high in the case of some old-growth forest that may be affected with its associated species. Importance of fish and other organisms at risk is moderate.

The sensitivity of receptors is moderate. No mechanism of impact is apparent for endangered or threatened bird species. Trees probably will not be killed; the most vulnerable species are generally the common moss and herbaceous understory species.

Scenario 7 - East Hyak, Keechelus Lake, Large Volume, Short Duration Diesel Spill

The magnitude or intensity of impacts is large due to the volume of the spill even though it spreads into a large area.

The extent of the impacts is large, since several miles of reservoir shoreline and lake surface are affected.

The duration of the impacts is moderate. Most of the product that does not evaporate is recovered.

The importance of receptors is low to moderate. The shoreline of the reservoir has low value as wildlife habitat because of the water level fluctuation. However, the reservoir has a good fish population, including trout and burbot.

The sensitivity of receptor is low to moderate. Some waterfowl or water birds could be affected by oiling of feathers leading to death from hypothermia. The populations are generally small and of common species. The fish may be less sensitive than in some situations because the water is deep and the amount of mixing into the water column is small.

Scenario 8 - Yakima River Crossing

8a Large Volume, Short Duration Diesel Spill

The magnitude or intensity of the impacts is high for the upland area and moderate for the river. Because of the geyser effect of the spill, the vegetation in the path of the spray is thoroughly covered.

The extent of the impacts is large, extending over several acres of upland and down river for up to five miles.

The duration of the impacts is moderate for the riparian area and river and long term for the upland area excavated for remediation of the contamination. The hay field should recover rapidly after removal of the spilled diesel, but the area with natural vegetation will be some time in recovering its former diversity.

The importance of receptors is high for the anadromous salmonids in the river and moderate for the riparian habitat and natural-growth uplands.

The sensitivity of receptors is high for the fish, but moderated somewhat by the dilution ratio. The vegetation is moderately sensitive.

8b Small Volume, Long Duration Spill

The magnitude or intensity of the impacts of the fuel itself is moderate because it is mostly contained in a relatively small area of soil. The intensity of impact from cleanup is high for the excavated area.

The extent of the impact is small because it is mostly maintained in the soil.

The duration of the impact is moderate to long because of the excavation. Revegetation will likely be slow and dominated by weedy species.

The importance of receptors is low, in that no aquatic organisms are affected and much of the affected area is part of a hay field with low diversity.

The sensitivity of receptors is low since they are mostly annuals or deep-rooted perennials.

Scenario 9 - Church Road, Moderate Volume, Short Duration Gasoline Spill

The magnitude or intensity of the impacts is high in the immediate upland area and in the stream where the full spill goes. It reduces to moderate with distance of dispersion.

The extent of the impacts is large, since the gasoline goes up to five miles down Currier Creek.

The duration of the impacts is moderate due to the expected two to five year recovery time of the vegetation and aquatic biota.

The importance of receptors is moderate, specifically for resident trout and riparian habitat.

The sensitivity of receptors is relatively high, including resident trout and riparian vegetation and wetlands.

Scenario 10 - Columbia River, Moderate Volume, Long Duration Gasoline Spill

The magnitude or intensity of the impacts is high for a very small area and low beyond that due to dilution.

The extent of the impacts is small for the high intensity impacts and large for low intensity types.

The duration is potentially very long, because the leak may be undetectable.

The importance of receptors is high, if salmon spawning occurs in the area if high fuel concentration in the gravel.

The sensitivity of receptors is high if salmon redds occur in the gravel with high concentrations of product, but low at the concentrations beyond the gravel/water interface.

Scenario 11 - Crab Creek, Moderate Volume, Long Duration Diesel Spill

The magnitude or intensity of the impact is moderate. The diesel leaks at a rate fast enough to give a concentration lethal to organisms in the wetland and creek. The cleanup activities have moderate to high intensity (moderate where vegetation is removed, high where soil is excavated).

The extent of the impact is large, including about 1 acre of wetland, 5 miles of Crab Creek, and 1,100 acres of reservoir.

The duration of the impact is moderate. After a few days of acutely toxic levels, it may take two years for the wetland areas to recover their vegetation cover and for fish habitats and populations to recover.

The importance of receptors is high, including possible habitat for sandhill cranes, a state-listed endangered species, resident trout habitat, and wetlands.

The sensitivity of receptors is high in the case of fish and wetlands, and low to moderate in the case of sandhill cranes (since this is not nesting area and they are very mobile at the times they may use the habitat).

Scenario 12 - Glade Road, Large Volume, Short Duration Gasoline Spill

The magnitude or intensity is moderate, in that the gasoline sprays out over several acres.

The extent of the impact is moderate, covering three acres of field and up to 20 acres of wetlands.

The duration of the impacts is moderate. Levels of acute toxicity lasts a few days and it may take two years for the wetland to recover.

The importance of receptors is moderate, including the wetlands recognized as priority habitat for fish and waterfowl and adjacent habitats for upland birds.

The sensitivity of receptors is high to the toxic components of gasoline. Both the wetlands and the wildlife and fish species directly affected. The wildlife could move out of harms way, but the fish could not escape.

Scenario 13 - Very Large Volume Gasoline Spill from a Barge in the Columbia River Above Bonneville Dam

The magnitude or intensity of the impact is high due to the very large volume of gasoline even through the water body is also relatively large.

The extent of the impact is large, covering over 7,000 acres of reservoir and downriver areas.

The duration of the impacts is moderate due to the dispersion and evaporation of gasoline and expected recovery of shoreline areas and other aquatic biota within two to five years.

The importance of receptors is high because of endangered and threatened anadromous fish runs and eagles. Depending on the season, there could be many juvenile salmon in the shallow edges, and a significant part of some runs could be vulnerable.

The sensitivity of receptors is probably low to moderate for such a scenario, tending to be moderate because of the dilution factors in such a large volume of water.

Scenario 14 - Very Large Volume Diesel Spill from a Barge Near the Mouth of the Columbia River

The magnitude or intensity of the spill is high due to the very large volume of the spill and the likelihood that currents and winds would concentrate it in some areas and disperse it in others.

The extent of the impacts is large because the currents and winds would disperse the product over a large area of estuary, bays, and islands, and into the Pacific Ocean.

The duration of the impacts is moderate, tending toward long because the diesel is subject to emulsification, causing it to be more persistent and because the affected habitat areas are expected to recover within 2 to 5 years.

The importance of receptors is high because of endangered and threatened species and protected marine mammals that could be exposed. Estuary areas tend to have higher concentrations of more sensitive resources than other areas.

The sensitivity of receptors is high for estuarine marshes, fish rearing areas, and some wildlife species that tend to use the surface waters.

Scenario 15 - Gasoline Tanker Truck Spill

The magnitude or intensity is high in a localized area, but moderate in the extended area of impact.

The extent is moderate, including creeks, wetlands, and shores of Lake Washington.

The duration of the impacts is short for acute toxicity levels and moderate for recovery of wetlands and shorelines (two to five years).

The importance of receptors is moderate to high. The wetlands are in an urban area with existing degradation factors, but are highly visible, and this takes on higher importance.

The sensitivity of receptors is moderate to high for wetland plants and for juvenile fish.

Scenario 16 - I 90 at Keechelus Lake

The magnitude or intensity of the impacts is high in a localized area of the spill, grading to moderate and then low with distance toward Lake Keechelus.

The extent of the impacts is small to moderate, in that it affects the creeks and the upper end of Keechelus Lake.

The duration of the impacts is moderate because of recovery of the spilled diesel and natural evaporation and degradation. Recovery of vegetation may take three to seven years because of short growing seasons.

The importance of receptors is low to moderate, including trout in the reservoir and the willow-dominated wetland/shoreline.

The sensitivity of receptors is moderate to low. The vegetation is expected to have moderate sensitivity and the fish low sensitivity because of the relatively small area affected relative to that available for fish.

Scenario 17 - Large Volume Tanker Spill at the Entrance of the Strait of Juan de Fuca

The magnitude or intensity of the impacts is high. The volume is large and winds and currents will concentrate it in some places at the shoreline.

The extent of the impacts is large (miles of shoreline).

The duration of the impacts is moderate, tending to be somewhat longer than some scenarios because much of the diesel may be subject to emulsification. Many areas will recover in two to five years, but some community changes may be longer-term

The importance of receptors is high because of threatened and endangered species and other protected resources. There are also important fishing and recreational areas.

The sensitivity of receptors is high, especially for some marine mammals, seabirds, and shorebirds and for some intertidal habitats.

TABLE 4-3 SUMMARY OF IMPACTS/SCENARIOS

Scenario	Magnitude (L,M,H)		Extent (S,M,L)		Duration (Long, Mod, Short)		Importance of Receptors (H,M,L)		Sensitivity of Receptors (H,M,L)		Severity	
	Oil	CU	Oil	CU	Oil	CU	Oil	CU	Oil	CU	Oil	CU
1 S 1	H	H	M	M	M	L	M	M	H	H	Mo ⁺	Mo
1 S 2	H	L	M	S	L	S	H	H	H	L	Se	Mi
1 L	L	H	M	M	M	L	M	M	H	H	Mo ⁻	Mo ⁺
2 S	H	H	L	L	M	L	H	L	M	L	Se ⁻	Se ⁻
2 L	H	H	S	S	M	S	L	L	L	L	Mo ⁻	Mo ⁻
3	H	H	L	M	M	L	M	M	M	M	Mo ⁺	Mo ⁺
4	H	H	M	M	M	S	M	M	H	H	Mo ⁺	Mo ⁺
5	H	H	L	M	M	S	M	M	M	L	Mo ⁺	Mo
6	M	H	M	M	M	M	H	H	M	L	Mo ⁺	Mo ⁺
7	H	L	L	M	M	S	M	M	M	L	Mo ⁺	Mi ⁺
8 S	H	M	L	L	M	M	H	H	H	H	Se ⁻	Se ⁻
8 L	M	M	S	S	L	L	L	L	L	L	Mo	Mo
9	H	M	L	L	M	M	M	M	H	M	Se ⁻	Mo ⁺
10	H	L	S	L	L	M	H	H	H	M	Se ⁻	Mo
11	M	M	L	L	M	M	H	H	H	H	Se ⁻	Se ⁻
12	M	M	M	M	M	M	M	M	H	M	Mo	Mo
13	H	M	L	L	M	S	H	H	M	M	Se ⁻	Mo ⁺
14	H	M	L	M	M	M	H	H	H	M	Se	Mo
15	H	M	M	M	M	M	H	H	H	M	Mo ⁺	Mo
16	H	H	M	L	M	M	L	L	L	L	Mo	Mo
17	H	M	L	L	M	M	H	H	H	M	Se	Mo ⁺

Oil = Initial Product Spill
CU=Cleanup and restoration.

HUMAN IMPACTS

Each of the scenarios has a set of conditions and features that will have different impacts on human residents nearby. The impacts range from being evacuated from one's home during a spill response to losing crops, livestock, or property from the spill or its aftermath. There are also costs of fire department responses and risks to workers. These things are not quantified or addressed in the same framework as the biological impacts. Their importance is acknowledged and further work will be committed to addressing them.

IMPACT SIGNIFICANCE

The significance of the impacts is addressed by comparing all of the components of impact for each scenario and noting the overall severity of the combined impacts of both the initial spill and the cleanup and restoration activities. Where more than one level of a component may apply in a scenario, the highest one is used. The assessment of overall severity for each scenario is given on Table 4-3.

It is clear that if a major spill occurs at a location with sensitive, important receptors, the impacts will be significant. Based on the scenarios evaluated, aquatic or wetland resources are more vulnerable to severe impacts than upland resources unless regulatory cleanup standards or other considerations require that soil be excavated over a large area. In these cases the cleanup impacts are more severe and long lasting than the initial impacts of the spilled products. It should also be noted that the types of products spilled are rather similar in their effects and characteristics and significantly different than heavy crude oil.

5.0 CONCLUSION

From the foregoing analysis the following conclusions can be drawn:

- There is a measurable but very small probability of spills from the proposed Cross Cascade Pipeline.
- The proposed pipeline can be expected to reduce the predicted number of spills per year from transportation compared to the No Project Alternative.
- The potential exists for significant environment impact if a spill occurs along the pipeline during operation.
- The potential for significant environmental impact under current transportation systems (the No Project Alternative) also exists.

- The probability of one or more spills at any specific location in any year, or over the lifetime of the pipeline, approaches zero and thus does not represent a significant threat to the environment.

Each of these conclusions are discussed in the following sections.

5.1 MEASURABLE BUT SMALL PROBABILITY OF SPILL FROM THE CROSS CASCADE PIPELINE

The probability of product spills can be viewed from two perspectives: 1) the probability that there will be spills anywhere along the pipeline and 2) the probability that a spill will occur at any given location.

Based on national hazardous liquids pipeline spill statistics, the proposed project has a statistically predictable rate at which pipeline spills are expected to occur. These rates are extremely low; one spill every 21 years when the pipeline is in its early years of operation (a probability of one or more spills will occur somewhere along the pipeline in any single year is less than 5%). Statistically, the rate of spills is predicted to increase in later years of operation due to aging of the pipeline (up to one spill every eight years). However, this increase is based on historical data that includes a large number of older pipelines (mainly built before 1950). In addition, many of these older lines have experienced much lower levels of maintenance. New large diameter pipeline are inspected and maintained at a much higher level and together with design and construction improvements will contribute to lowering spill rates in the future. Due to these changes in design, technology and maintenance, the Cross Cascade Pipeline can reasonably be expected to have lifetime spill rates on the order of those predicted for the initial 5 years of operation. The analysis that has been performed includes correction factors for older pipelines making it conservative (i.e., it predicts high spill rates in later years than should actually be experienced).

The probability that a spill will occur at any specific location along the pipeline approaches zero. The probability that a spill would occur along any 1,000 feet of right of way is less than 0.0001%. The probability along 1,000 feet of right of way was examined because it represents a typical exposure for sensitive environmental resources (stream crossing, wetlands, etc.) or individual homeowners' properties in semi rural areas. Likewise the probability that one or more spills would occur along any given 12 miles of pipeline right of way representing larger landowners and more regional resources, is one fourth of one percent (0.25% vs. less than 5% for the entire pipeline) per year.

5.2 NUMBER OF SPILLS FROM TRANSPORTATION WILL BE REDUCED

A prediction of increased demand for refined petroleum product consumption in the eastern Washington market area will correspondingly increase the need for transportation of RPP. Statistical rates for spills from current transportation via barge and tanker truck (Yellowstone and Chevron pipelines are assumed to continue and thus do not differentially affect the conclusions)

when compared to the proposed project show that from three to six spills per year may be avoided by use of the Cross Cascade Pipeline.

This conclusion is based on the assumption that if the pipeline is not built increases in both barge and tanker truck transportation must occur to satisfy increased demand. However, for any increase in shipments via barge to occur, increased imports up the Columbia River via ocean-going barge or tanker ship must also occur. This increase in imports (from California and Puget Sound refineries) may be limited because it must compete economically with increased tanker truck transportation directly from the Seattle region. The analysis, in one way, understates the risk of spills from barge transportation. It assumes that barges will transport increased volumes of product in the future (but at the same percentage share of total volume transported); but the spill risk for delivery of these volumes to Portland via the Columbia River has not been included.

As part of the comparison of the project with current transportation systems, it should be noted that barge transportation exhibits total spill risk (expected number of spills per year) in the same range as the proposed pipeline. Tanker trucks, because a greater number of trips are required to transport similar total volumes of product, make a larger contribution to total expected spills. The tanker truck risk is somewhat overstated in the early years because it assumes that all trips are from Seattle to Pasco for all years. In earlier years a larger portion of the trips will be to nearer destinations (Ellensburg, Yakima, etc.) which are shorter trips that reduce the risk (risk is a function of distance). In later years the average trip length will increase as more deliveries are made to more distant locations increasing risk to the levels calculated and reported here.

5.3 POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACT FROM PIPELINE SPILLS

In many of the spill scenarios examined critical sensitive resources were exposed to product (gasoline or diesel) with short term toxic effects on biota and contamination of surface water resources. Short term morbidity of plants and animals, soil and surface water contamination and hazardous conditions due to volatile materials would all likely occur. Subsequent emergency response and cleanup operations, while intended to contain contamination and remove it from the environment, in many cases requires soil removal and other invasive activities that also have impacts. Long term chronic impacts are determined to be potentially less significant due to naturally occurring mechanisms in the environment that buffer, disperse, absorb or degrade material introduced to the environment by an accidental release and not removed by cleanup operations. In the case of gasoline spills in particular there is a tendency for a significant portion of the released product to evaporate (volatilize).

Of special note are potential impacts to sole source aquifers. A scenario (Scenario 1) which assumed a spill over the Cross Valley Aquifer found that under both short and long time period releases contamination did not intrude into the ground water. This was because of the depth to groundwater, relatively low permeability of soils overlaying the aquifer and the time frame of the spill. Based on this scenario, which is thought to be typical of the area, it is unlikely that groundwater contamination would occur in the event of an accidental pipeline release.

Several scenarios assumed spills near surface water bodies (creeks and rivers). These scenarios also assumed that the spill would enter the water course. These spills have the ability to cause significant short term impacts to vegetation, resident fish, and avifauna. In more dynamic environments such as streams and rivers, impacts can be extended to a significant area, but the dynamic nature of the environment also tends to dilute and reduce impacts with time. In less dynamic environments such as wetlands, relatively less dilution would occur, cleanup operations are more difficult and long term recovery of product and restoration of the habitat less viable.

The scenario of a slow leak at the Columbia River (underwater crossing) illustrates that a leak could persist for a lengthy period of time without detection. However, due to the extremely large dilution of such a release, acute effects on fish would be confined to a small area, and chronic effects would not be expected.

5.4 POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACT FROM EXISTING TRANSPORTATION SYSTEM

The impact analysis of spill scenarios for both tanker truck and barge transportation illustrate situations where significant environmental impacts could occur as the result of a spill from these modes. Of the alternative systems, tanker trucks may generate somewhat lower impacts because the total spill volume is limited to approximately 150 barrels (if the entire load is spilled). However, introduction of petroleum products of this magnitude in some environments can still be significant as is shown by the scenarios analyzed..

Spills from barges in the Columbia River system either upriver from Portland or near the river estuary pose a threat to migrating fish, especially salmon, and to the adjacent riparian habitats associated with the river ecosystem. Young fish returning down river are often more concentrated than upriver migrants and could be significantly impacted. A spill in the river's estuary near salt water could affect important marsh and tidal habitats which are critical rearing areas for a number of species and environments that are difficult to restore following a spill.

A marine spill from a ship or barge in proximity to the coastline has the potential to generate broadly distributed and significant impacts. Marine mammals and birds exposed and unable to avoid the highly toxic petroleum product can experience significant mortality. Emergency response and cleanup operations in the marine environment, especially under inclement weather conditions, are difficult and have much longer response times than shore based spill response situations.. It should be noted that refined products with high volatility should not persist in the environment for significant lengths of time (as compared to crude oil for example).

5.5 OVERALL THREAT TO THE ENVIRONMENT IS LOW

The spill scenario analysis demonstrates that a spill at a specific location near sensitive resources does have the potential to generate specific significant impacts to the environment. Further, such

plausible scenarios occur for all three modes of transportation. Therefore, in terms of the potential to significantly impact the environment, both the project and the No Project Alternative have such potential.

However to fully assess risk or threat to the environment, the probability that such an impact could occur must simultaneously be considered. The analysis shows that the probability for a spill at any given location on the pipeline (defined as 1000 feet of right of way) is approximately zero. Thus, while the potential for significant impacts can be shown to exist, the potential that such impacts will occur is extremely low rendering the risk or threat to any specific environmental resource from pipeline spills to be very low. Finally, since the proposed project has been shown to reduce the total number of expected spills, the overall threat to the environment from product spills is reduced by the pipeline.

**Cross Cascade Pipeline Project/
Product Spill Analysis**

**for
Olympic Pipe Line Company**

**Job Number: 05591-023-020
February 28, 1997**

TABLE OF CONTENTS

SUMMARY	1
INTRODUCTION.....	2
1.0 PROPOSED CROSS CASCADE PIPELINE SPILL RISK	3
2.0 ALTERNATIVE TRANSPORTATION RISK.....	6
2.1 EASTERN WASHINGTON RPP DEMAND	7
2.2 TANKER-TRUCK TRANSPORTATION SPILL RISK.....	10
2.3 RIVER BARGE TRANSPORTATION SPILL RISK	11
3.0 COMPARISON OF SPILL RISK	11
4.0 ASSESSMENT OF ENVIRONMENTAL EFFECTS	12
4.1 SPILL SCENARIOS - DEFINED	13
4.2 ASSESSMENT OF IMPACTS OF OIL SPILLS	16
5.0 CONCLUSION	29
5.1 MEASURABLE BUT SMALL PROBABILITY OF SPILL FROM THE CROSS CASCADE PIPELINE.....	30
5.2 NUMBER OF SPILLS FROM TRANSPORTATION WILL BE REDUCED	30
5.3 POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACT FROM PIPELINE SPILLS	31
5.4 POTENTIAL SIGNIFICANT ENVIRONMENTAL IMPACT FROM EXISTING TRANSPORTATION SYSTEM	32
5.5 OVERALL THREAT TO THE ENVIRONMENT IS LOW	32

